UNCERTAINTIES AND INTERDISCIPLINARY TRANSFERS THROUGH THE END-TO-END SYSTEM (UNITES)

THE UNITES TEAM YEAR 1 OVERVIEW

Philip Abbot (OASIS Inc.) and Allan Robinson (Harvard University)

Presented at ONR Uncertainty DRI Review and Planning Meeting

Hubbs Hall, Scripps Institution Of Oceanography

June 20, 2002

Environmental Uncertainty and Its Effect on Sonar Performance -- UNITES Team -- Outline of Presentation

Scientific Overview: Robinson
- End-to-End Concept
- PRIMER End-to-End Formulation
- Theoretical Approaches

Sonar Performance Predictions Incorporating Environmental Variability: Abbot
- Systems Implications -- ECS Passive Example
- ECS TL Fluctuations

PRIMER Efforts
- Physical Oceanography: Gawarkiewicz
- TL Fluctuations: Lynch (Abbot)
- Shelfbreak PRIMER TL Estimates and Statistics: Chiu
- Coupled Data Assimilation: Lermusiaux

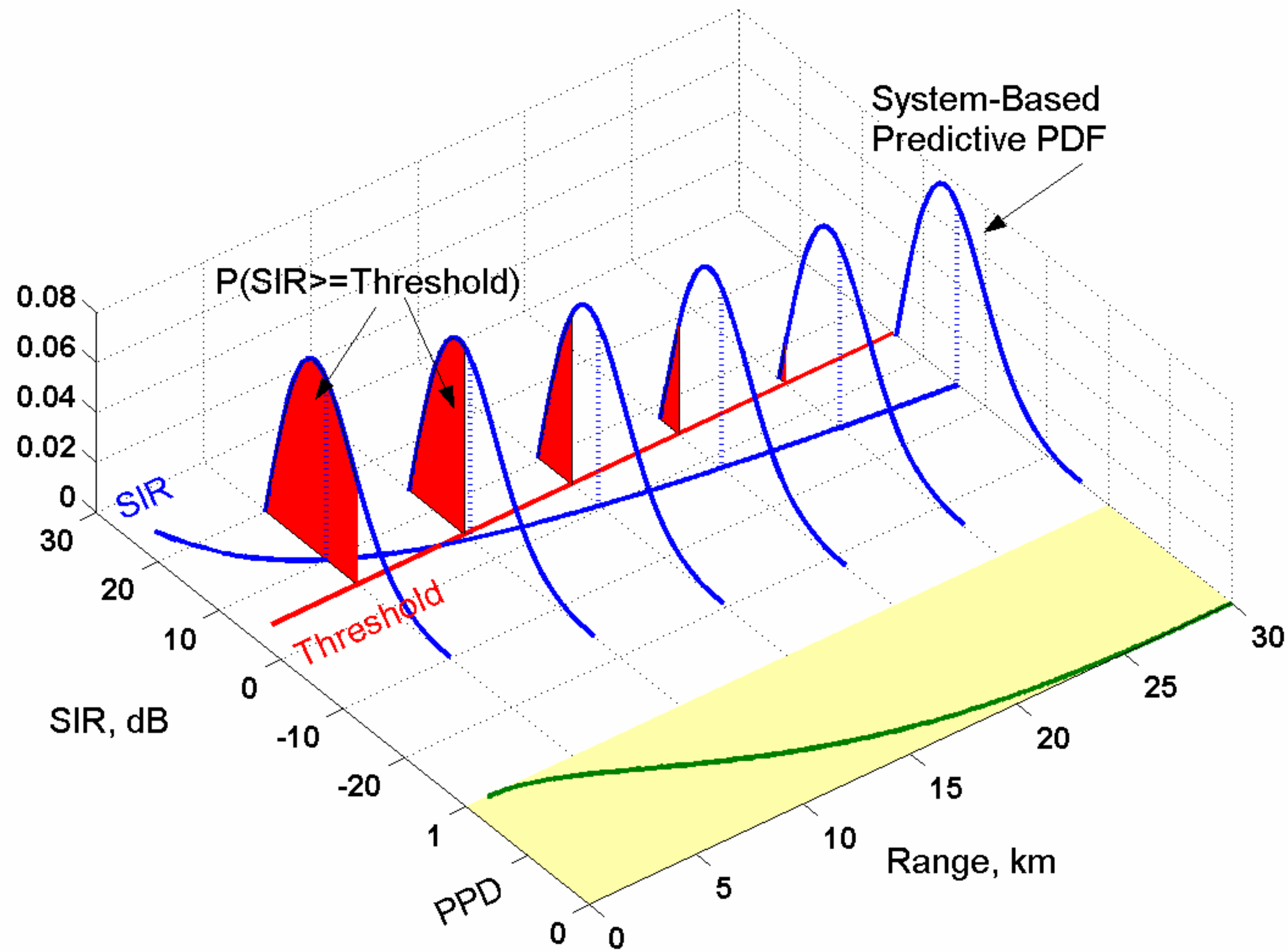
ECS Efforts
- Reverberation Statistics: Pulli
- ECS Bottom Uncertainty: Bartec

- INSERT ARR’s TALK

Sonar Performance Predictions Incorporating Environmental Variability

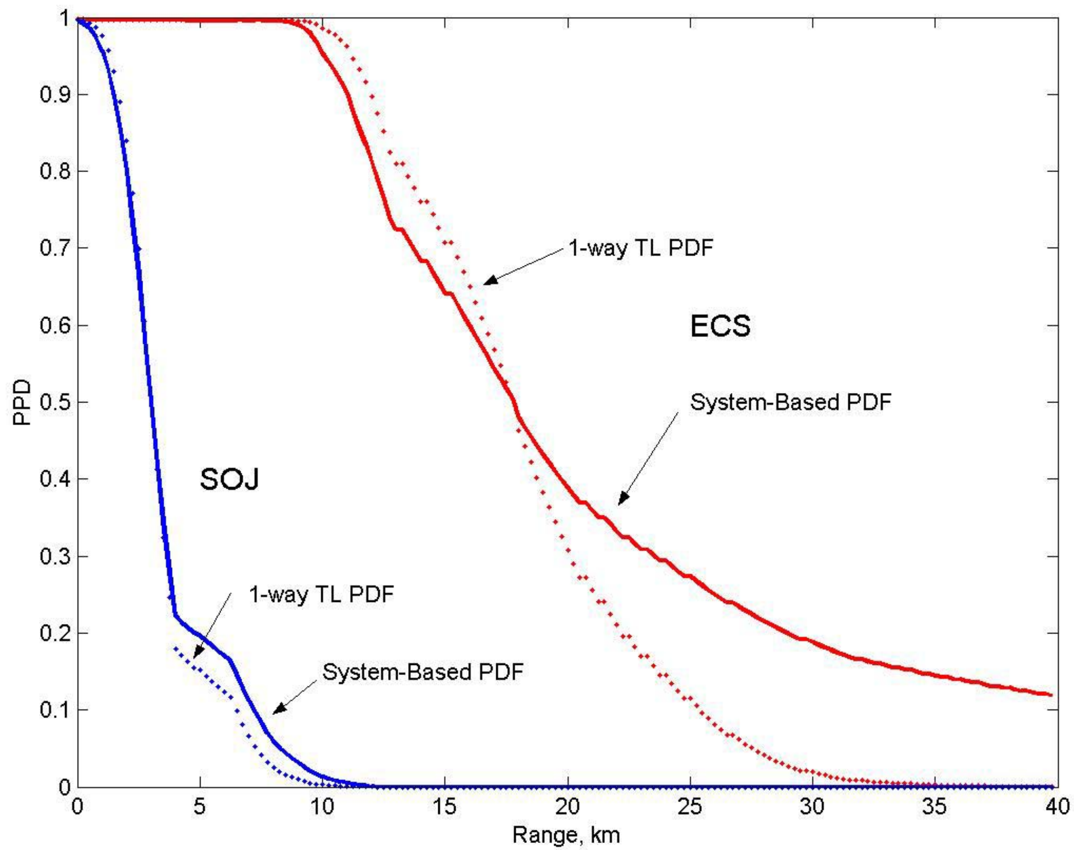
- System Implications -- ECS Passive Example
- ECS TL Fluctuations

Illustration of probabilistic system performance prediction using System-Based Environmental PDF which incorporates environmental uncertainty



Predictive probability of detection (PPD) for simulated passive system, ECS and SOJ

(downward refracting sound speed conditions)
FOM = 65 dB, 400 Hz, BW=282 Hz, T=640 msec



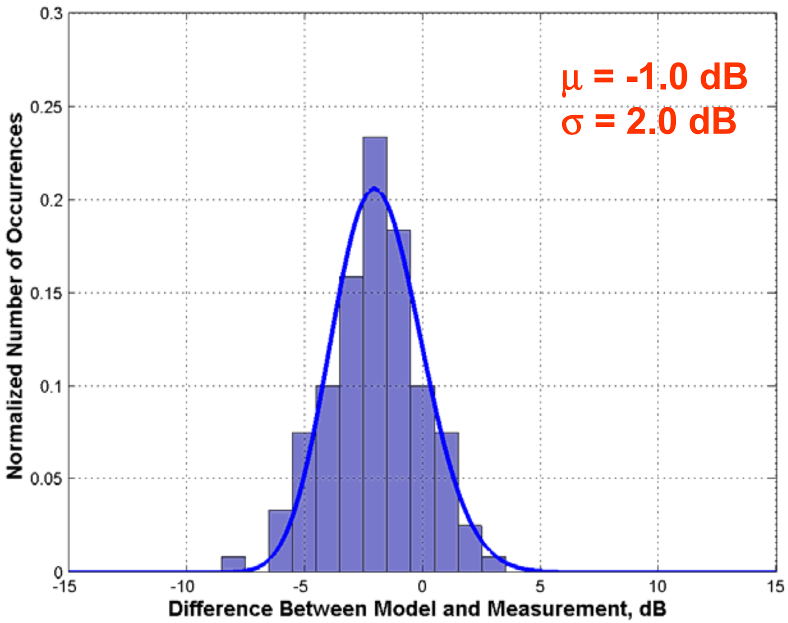
Systems-Based PDF Assumptions:

- Ls -- Log normal, σ = 3 dB
- Ln -- Uniformly distributed in angle, phase-random in TBW, σ = 0.4 dB
- Nrd -- Delta function

1-way TL PDFs -- Measured

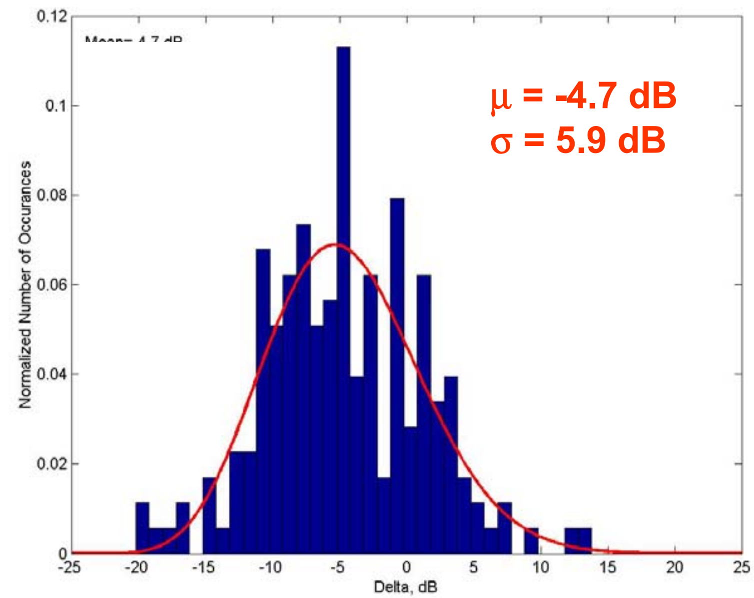
Measured 1-Way TL Environmental PDF, ECS and SOJ, wrt Competent Model, 400 Hz, BW = 282 Hz, T = 640 msec, R ≤ 40km

ECS



10 Tracks (4 directions)
PDF around 1 model

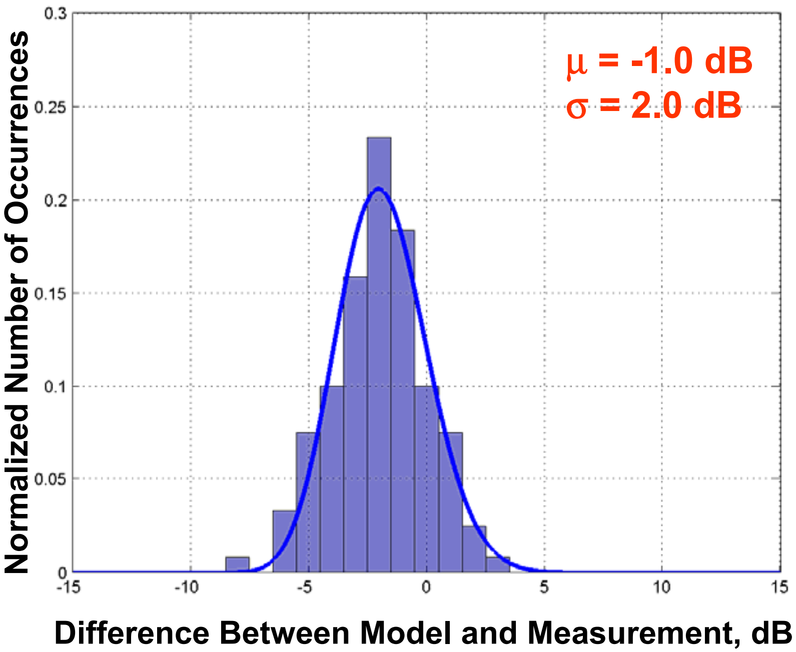
SOJ



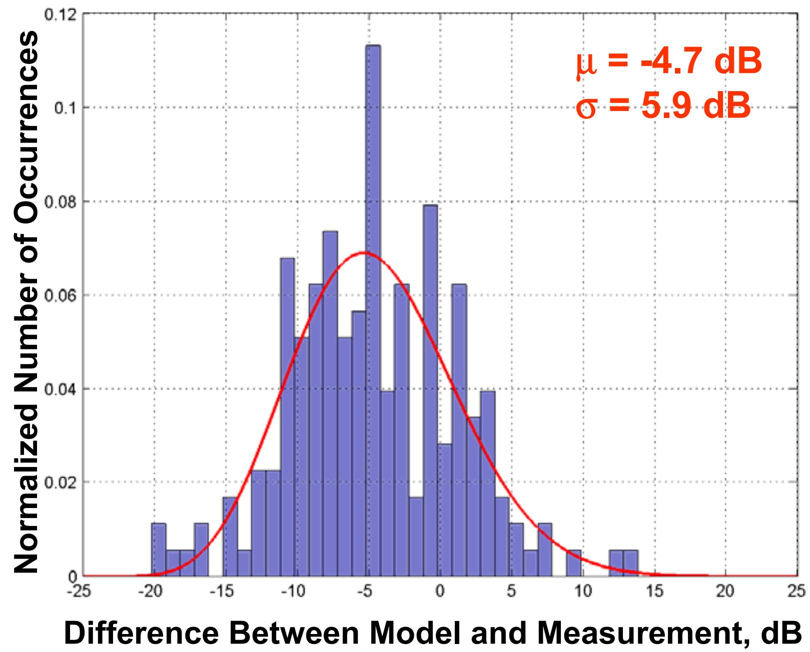
15 Tracks (5 directions)
PDF around 5 indiv models

Measured 1-Way TL Environmental PDF, ECS and SOJ, wrt Competent Model, 400 Hz, BW = 282 Hz, T = 640 msec, R ≤ 40km

ECS



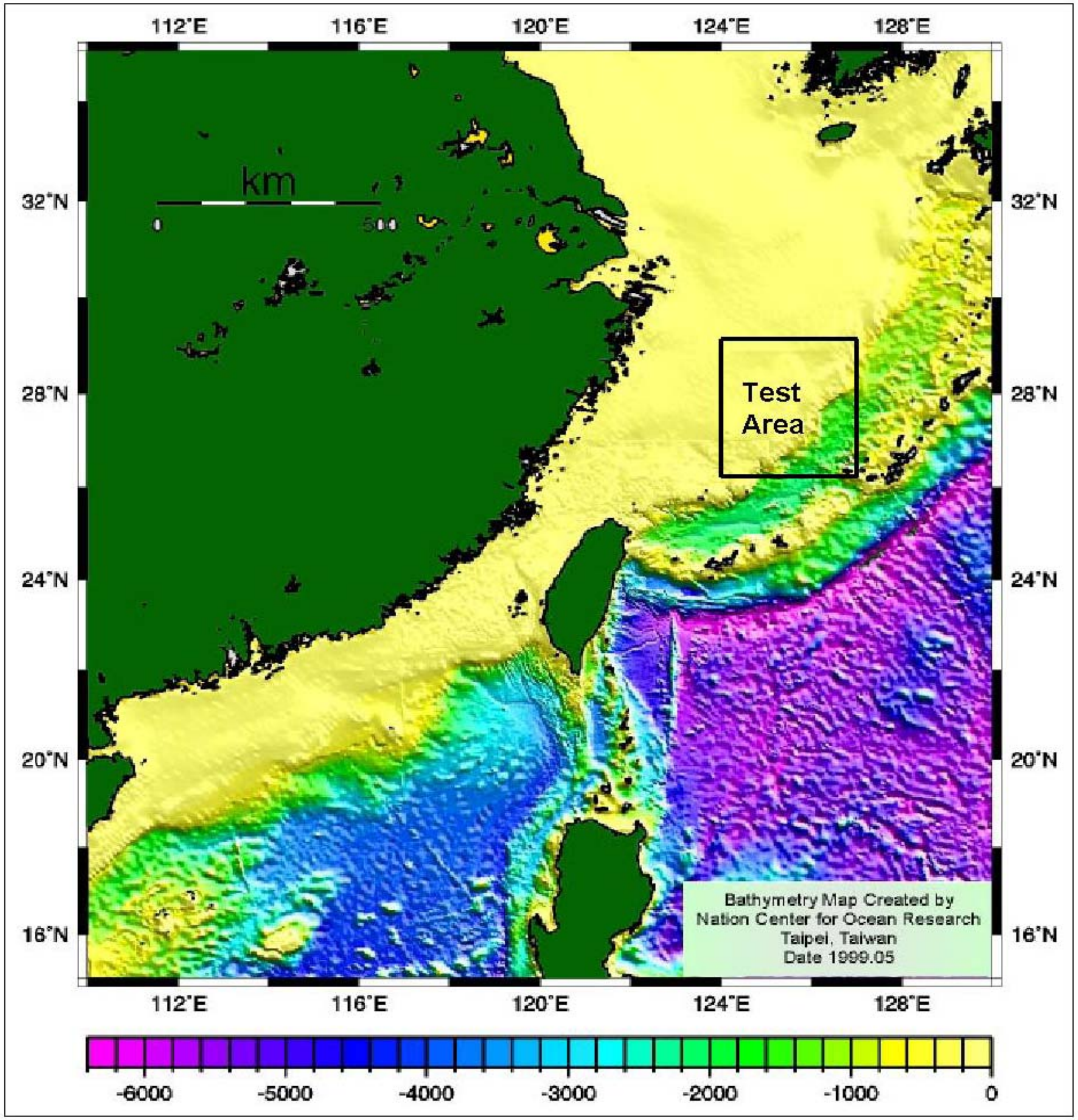
SOJ



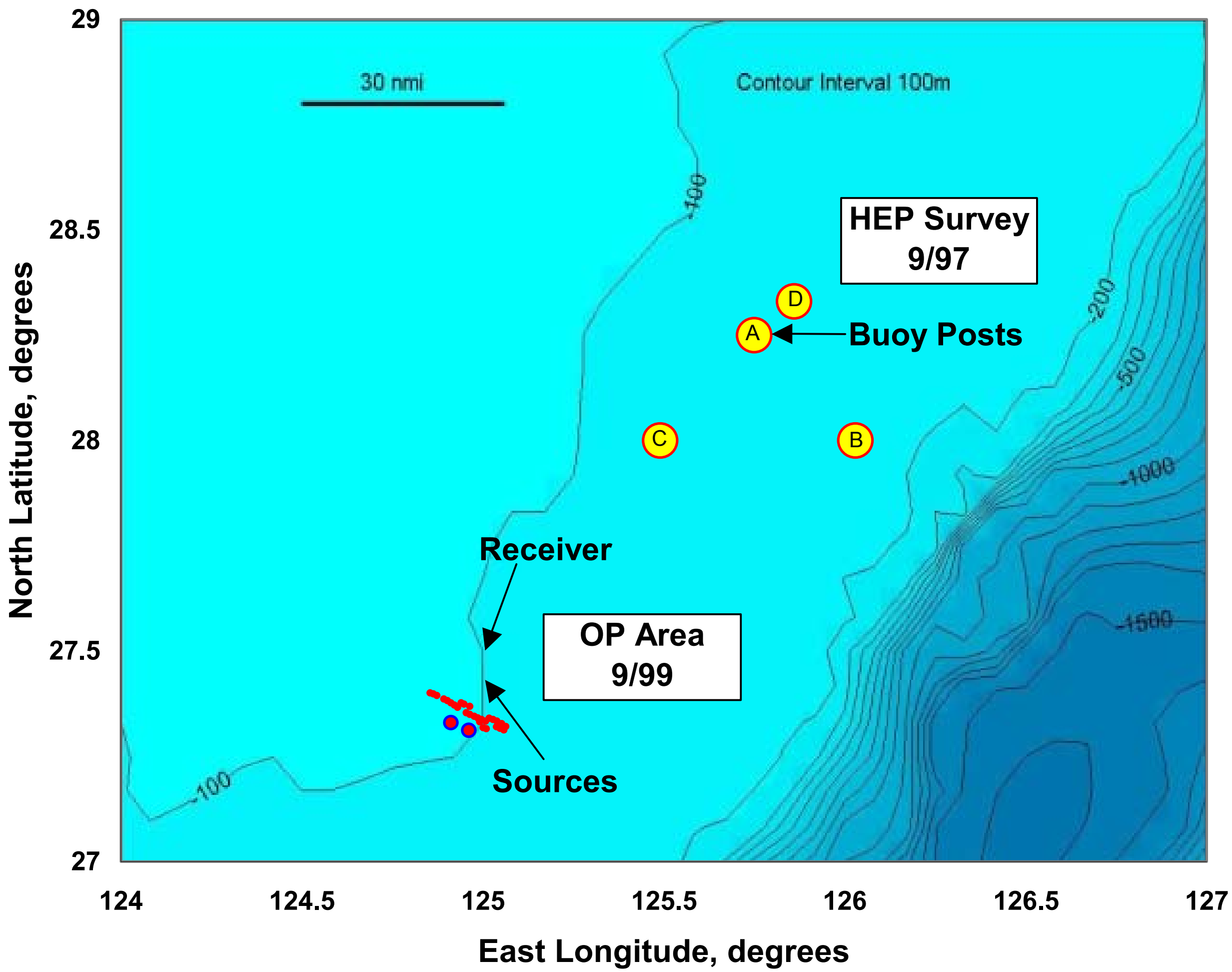
10 Tracks
PDF around 1 model

15 Tracks
PDF around 5 indiv models

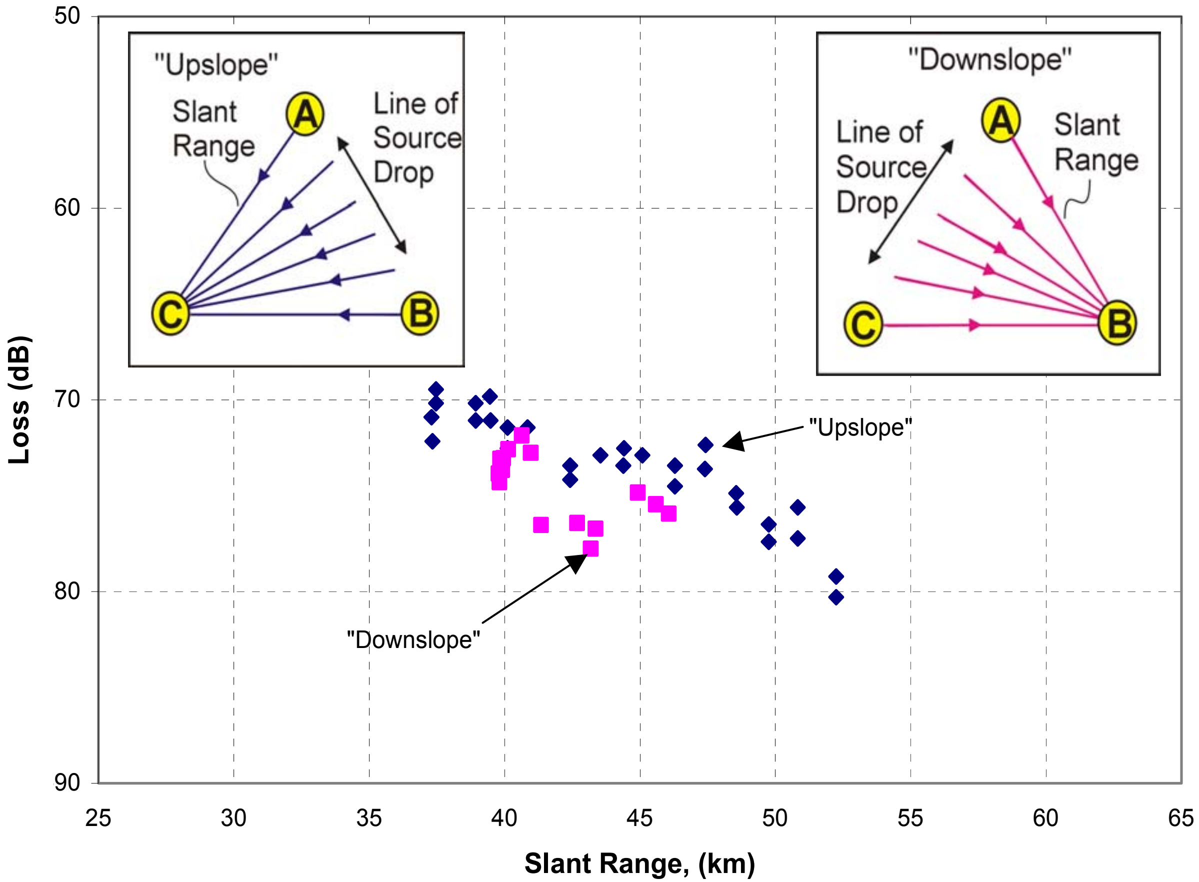
ECS Area of Present Focus



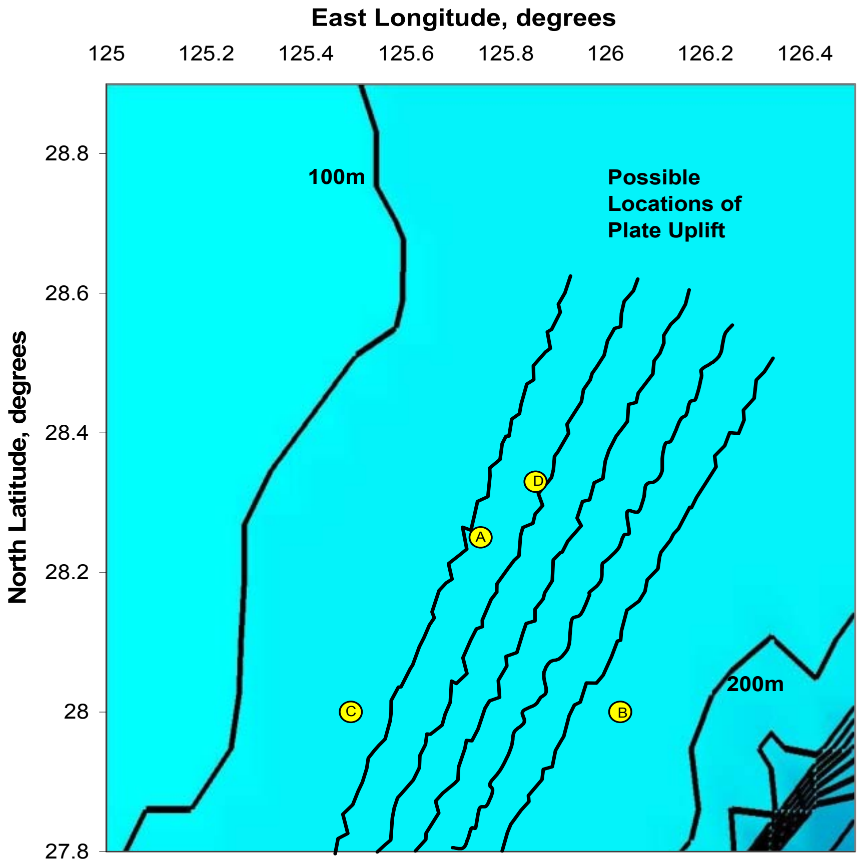
Blow-up of Area



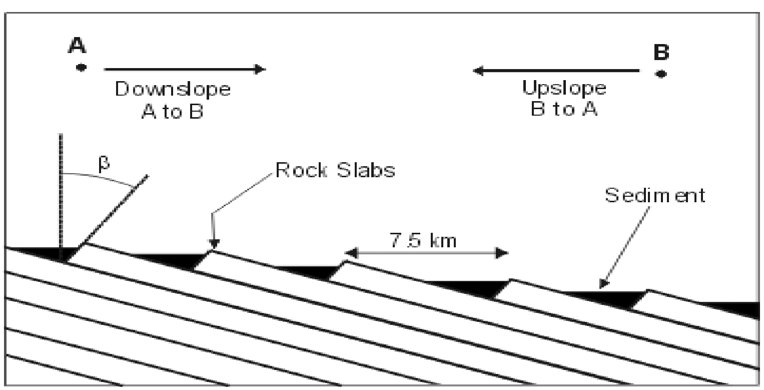
ECS Measured TL vs. Slant Range



Hypothetical Bottom Consistent with TL Data

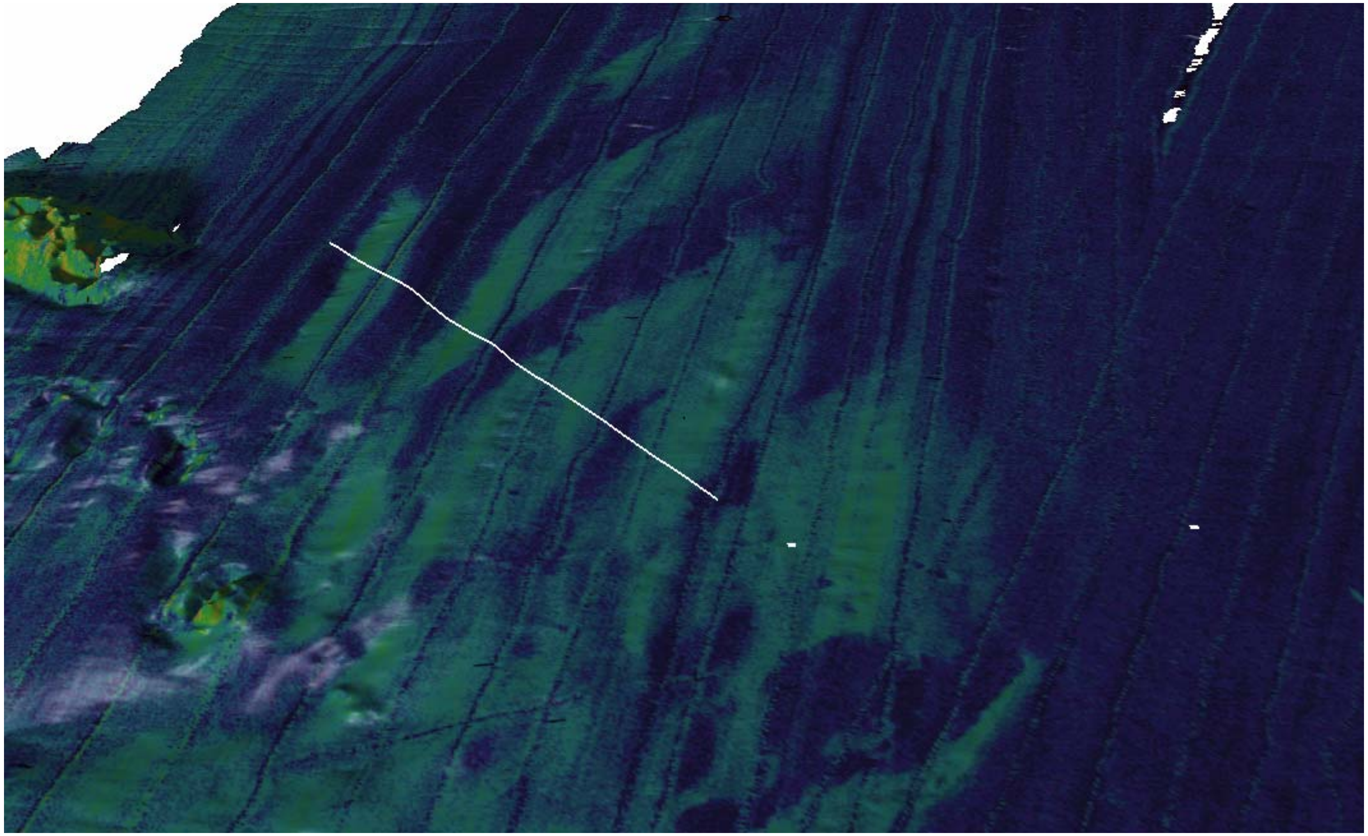


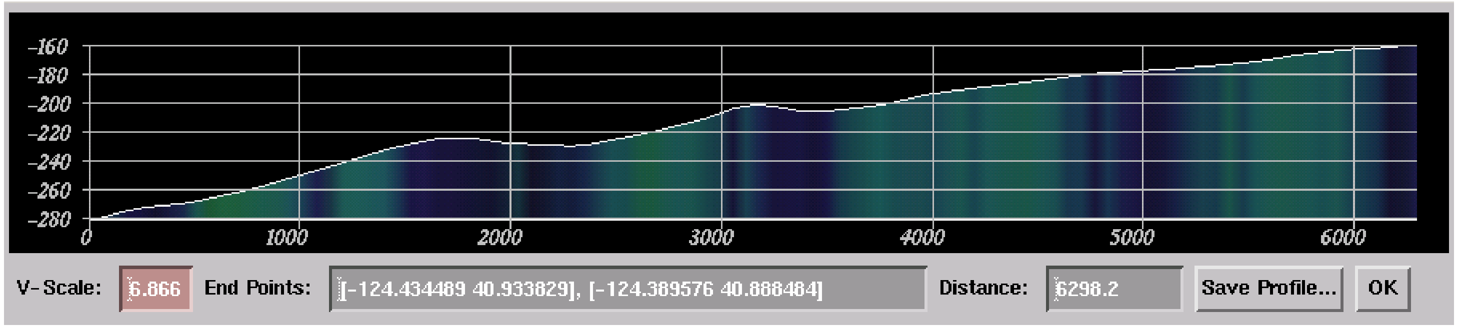
Plan View



Elevation View

Example of Ridged Bottom, Oregon Coast
From L. Mayer, UNH





Conclusions

- **Systems Implications**
  - All classes of variability affect the PPD
    - Environmental (TL, Ambient Noise and Reverberation)
    - Non-Environmental (Ls, TS, self-noise, Nrd)
  - Some environments less sensitive than others
  - Variability controls the slope of PPD
  - PPD provides operator with basis for trading detection performance with mission objectives

Conclusions (Continued)

- **ECS TL Fluctuations --** Although ECS TL is small,
  - Directional propagation effects exist
  - Measured TL variability limited by bottom complexities, for ECS summer environment

UNITES Happenings

- **Acoustic Variability Conference, Italy, Sep. 02**
  - Abbot and Dyer, Sonar performance predictions based on environmental variability
  - Abbot, Gedney, Dyer and Chiu, Ambient noise and signal uncertainties during the Summer shelfbreak Primer Exercise
  - Duda, Relative influences of various environmental factors on 50-1000 Hz sound propagation in shelf and slope areas
  - Lermusiaux and Chiu, Four-dimensional data assimilation for coupled physical-acoustical fields
  - Lynch, Fredricks, Colosi, Gawarkiewicz, Newhall, Chiu and Orr, Acoustic effects of environmental variability in the SWARM, PRIMER and ASIAEX experiments
  - Robinson, Abbot, Lermusiaux, and Dillman, Transfer of uncertainties through physical-acoustical-sonar end-to-end systems: a conceptual basis
- **Meetings**
  - Seabed Variability and MIT Uncertainty Teams at OASI S -- Feb. 02
  - COMSUBDEVRON12 - April 02
  - Sensor Optimization Working Group - Oct. 01
  - COMSUBPAC - Oct. 01

UNITES Happenings (Continued)

- **Other Publications/Presentations**
  - Abbot, Celuzza, Dyer, Gomes, Fulford and Lynch, Effects of East China Sea shallow water environment on acoustic propagation, Submitted for IEEE JOE
  - F. Bahr, G. Gawarkiewicz, K. Brink, R. Beardsley, M. Caruso, Response of the Shelfbreak Front to Strong Wind Forcing during the Winter PRIMER Experiment, Ocean Sciences Meeting, Hawaii, Feb. 2002
  - G. Gawarkiewicz, F. Bahr, K. Brink, R. Beardsley, M. Caruso, J. Lynch, C.-S. Chiu, A large amplitude meander of the shelfbreak front in the Middle Atlantic Bight: Observations from the Summer PRIMER Experiment, Manuscript submitted to Journal of Physical Oceanography, April 2002
  - C. Linder, G. Gawarkiewicz, and R. Pickart, Seasonal variations in the detachment of the bottom boundary layer in the Shelfbreak Front, Middle Atlantic Bight Physical Oceanography and Meteorology Workshop, U. Connecticut, October, 2001
  - Rasmussen, G. Gawarkiewicz, K. Buessler, M. Charrette, W. B. Owens, and S. Lozier, Radiochemical Evidence for Boundary Current Transport in the Middle Atlantic Bight, Ocean Sciences Meeting, Hawaii, Feb. 2002

OASIS Work In Progress

- Formulation of End-to-End Problem (HU)
- PRIMER Ambient Noise and TL Fluctuations (NPS/WHOI)
- ECS Active Sonar End-to-End Problem
  - ambient noise
  - reverberation
  - false alarm
- ECS TL Fluctuations